The Meach Lakes Brook Trout Fishery

1981 – 1985

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1987

Haliburton-Hasting Fisheries Assessment Unit
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Creel surveys were conducted on Meach Lake (area = 42 ha) and Little Meach Lake (area = 30 ha) in northern Hastings County continuously from spring 1981 through winter 1985. Results indicate that the lakes jointly support an exceptionally good fishery for native brook trout. Average annual fishing effort amounts to 65 $hrs.ha^{-1}.yr^{-1}$ on Meach Lake and 82 $hrs.ha^{-1}.yr^{-1}$ on Little Meach Lake. Yields of native brook trout from the two lakes have averaged 3.19 $kg.ha^{-1}.yr^{-1}$ and 4.02 $kg.ha^{-1}.yr^{-1}$, respectively. Yields of hatchery-reared brook trout planted in the lakes averaged 0.51 $kg.ha^{-1}.yr^{-1}$ and 0.66 $kg.ha^{-1}.yr^{-1}$, respectively, and represent return $ of 13.6 to 44% by weight, of the fish planted. In this instance, stocking is unnecessary.

The native brook trout population exhibits an annual mortality rate of about 90%. The mean age of harvested fish is 29 months. The mean age at first maturity (Lysak's formula) is 27.2 months. Sixty percent spawn for the first time in their second year. The growth rate is moderate: the average fork length of 4 yr old fish is 37 cm. Available data suggest this population is fished very heavily. Although brook trout yields greatly exceed those recommended by SPOF WG 12, they seem consistent with those from other productive fisheries.

The estimated relationship between brook trout potential yield ($\hat{Y}_{BT}$, $kg.ha^{-1}.yr^{-1}$) and Lake surface area (A,ha),

$$\log_{10} \hat{Y}_{BT} = 1.59 - 0.68 (\log_{10} A)$$

was stronger and more robust than that between brook trout potential yield and a morphoedaphic index (MEI, $mg.l^{-1} .m^{-1}$),

$$\log_{10} \hat{Y}_{BT} = 1.14 (\log_{10} MEI) - 0.77.$$

THE MEACH LAKES BROOK TROUT FISHERY, 1981-1985

INTRODUCTION

This report presents the results of four years of creel survey work conducted by the Haliburton-Hastings Fisheries Assessment Unit (HHFAU) on Meach Lake and Little Meach Lake, Hastings County, Ontario. Despite the large number of brook trout (Salvelinus fontinalis) lakes in the province (Ontario Ministry of Natural Resources [OMNR] 1978), information on sport fishing effort and harvests from natural brook trout populations is sparse (OMNR 1982). In view of this, the results here should be especially useful.

STUDY AREA

The Meach Lakes are located in McClure Township in the northwest corner of Hastings County, 40 km northwest of the Village of Bancroft. Meach Lake has a surface area of 42 ha and flows into Meach Creek, a tributary of the Madawaska River. Little Meach Lake is somewhat smaller (30 ha) and drains via a short, navigable creek into Meach Lake. Water levels reflect the status of beaver dams at the outlet of each lake.

The lakes are well-suited to brook trout production. The 666 ha catchment supports 6 permanent tributary streams which are sufficiently well-protected and cool to sustain young brook trout throughout the year in their lower reaches. Overhanging and fallen trees provide good cover, especially along the western shores of both lakes. Areas of rock, gravel, and sand occur near shore but the substrate throughout much of the littoral zone is either sandy mud or mud overlain by quite extensive mats of pipewort (Eriocaulon sp). The largest of the 3 known brook trout spawning areas is situated at a spring near the Little Meach Lake outlet.

Water quality is good. Dissolved oxygen concentrations, water transparency, and nutrient concentrations in Meach Lake, and presumably also in Little Meach Lake, are characteristic of mesotrophic waterbodies (Hulsman 1983) although morphometric characteristics are more typical of oligotrophic lakes. Hypolimnetic dissolved oxygen depletion in late summer probably places a minor constraint on the depth distribution of brook trout at that time.

Food supplies are good. The standing crop of benthic invertebrates (30.8 $kg.ha^{-1}$) is dominated by ephemeropteran nymphs, amphipods (Gammarus sp) and dipteran larvae. The crayfish (Orconectes virilis) is also fairly abundant.

Other fish species present in the lakes include white sucker (Catostomus commersoni), brown bullhead (Ictalurus nebulosus), fathead minnow (Pimephales promelas), creek chub (Semotilus atromaculatus), pearl dace (S. margarita), northern redbelly dace (Phoxinus eos), finescale dace (P. neogaeus), golden shiner (Notemigonus crysoleucas), and brook stickleback (Culaea inconstans).

Shoreline development consists of several unofficial crown land campsites on both lakes, a single unused cottage on Meach Lake, and 2 crown land recreational camps on Little Meach Lake. The nearest all-season road is 1.8 km distant. The connecting trail can be traversed by snowmobiles in winter and by 4-wheel drive vehicles at other times.

The brook trout fishing season extends from January 1 to September 30 each year, but poor ice conditions usually discourage fishing activity for up to 3 weeks before breakup, which usually occurs during April. The daily catch and possession limits are 7 brook trout per angler. Anglers are limited to the use of 2 lines during winter and 1 line during the open water period. The use of live bait is permitted.

METHODS

CREEL SURVEY

The fishing day was considered to extend from 07:00 to 17:00 in winter and from 06:00 to 22:00 during the open water season. Days were stratified into workdays and holidays. Fishing party counts were conducted every 2 hours throughout each sampling day. During 1983, 1984, and 1985 we conducted sampling on 1 workday and 1 holiday each week. During open water periods in 1981 and 1982, however, sampling on workdays was incidental to other assessment unit work on the lakes.

All fishing parties present were interviewed to determine party size and fishing success and to obtain access to harvested fish. Fork length, weight, and fin clip data were recorded in the field for each fish examined. Viscera were frozen and examined under laboratory conditions to establish sex, maturity, and stomach contents. Scale samples were taken from all fish seen. A large number of brook trout heads and pectoral fin rays was also retained and estimates of fish age were subsequently obtained using scales and a number of other structures (cleithral, opercle and subopercle bones, and finrays), for comparative purposes. January 1 was assigned arbitrarily as the birthdate of all brook trout. The outer edge of scales from all winter-caught fish was assumed to represent an annulus and ages of these fish are represented in this report using the superscript "°" (ie 3°). Ages of fish harvested during the open water period are shown with the superscript "+" (ie 3^{+}).

DATA ANALYSIS

Data from surveys conducted on both lakes were analysed using the CREESYS version 3.2c programs (Lester and Trippel 1984) to estimate fishing effort and numbers of fish harvested. Estimates of mean fish weight and yield were calculated independently.

RESULTS

ANGLER CHARACTERISTICS

In winter about 80% of all anglers interviewed on both lakes were either locals (people living less than 50 km from the lakes), cottagers from nearby Mink Lake, or Crown land recreational camp holders. During the open water season, however, locals comprised only a small proportion of the anglers while non locals were relatively numerous.

In winter almost all anglers used minnows as bait, although some used worms, grubs, liver, or corn. At other times most anglers either trolled with artificial lures and natural bait, or still/drift-fished with natural baits. Fly fisherman were rare.

FISHING EFFORT AND SUCCESS

Meach Lake

Estimates of fishing effort, fishing success, and harvest are presented in Table 1 and Figure 1. On average, fishing effort amounted to 1765 angler hrs (42 hrs.ha^{-1}) in summer, 950 hrs (23 hrs.ha^{-1}) in winter, and 2715 hrs (65 hrs.ha^{-1}) for both seasons combined. Mean harvests consisted of 474 brook trout (including 110 stocked fish) during the open water period and 245 trout (including 70 stocked fish) during winter. Approximately 25% of the mean annual harvest of 719 fish were of hatchery origin. The average annual yield (3.70 kg.ha^{-1}) consisted of 3.19 kg.ha^{-1} of native brook trout and 0.52 kg.ha of stocked brook trout.

Angling success ranged from 0.19 to 0.37 brook trout kept per angler hour (Figure 1). Seasonal average CUE values were 0.28 fish.hr^{-1} (64 g.hr^{-1}) for the open water season and 0.24 fish.hr^{-1} (47 g.hr^{-1}) in winter. For native fish only, CUE values were 0.24 fish.hr^{-1} (54 g.hr^{-1}) in the open water period and 0.21 fish.hr^{-1} (40 g.hr^{-1}) in winter.

The estimated age composition of seasonal catches of native brook trout is shown in Figure 2. More detailed information is provided in Appendix 1. The apparent predominance of 3 yr old fish in winter catches is an artifact resulting from our designation of January 1 as the birthdate of all brook trout. In fact, at the start of the winter season these fish are still in their second year and are members of the same year class most abundant in catches during the previous open water season.

Table 1. Fishing effort and success (angler hours) and fish harvest from Meach Lake, 1981-1985

Season	Effort (angler hrs)		CUE (fish kept)		Harvest		Yield(kg.ha^{-1})		
	hours	hrs.ha^{-1}	no.hr^{-1}	g.hr^{-1}	number	kg	Native	Stocked	Total
1981									
open water	1811	43	.352	75	639	136.11	2.82	0.42	3.24
1982									
winter	1151	27	.191	40	220	46.20	1.02	0.08	1.10
open water	2509	60	.179	43	450	108.45	2.47	0.11	2.58
1983									
winter	578	14	.197	37	113	21.47	0.51	0.00	0.51
open water	1411	34	.287	82	405	115.02	2.72	0.02	2.74
1984									
winter	782	19	.214	44	168	34.10	0.76	0.05	0.81
open water	1327	32	.302	56	401	74.04	1.14	0.62	1.76
1985									
winter	1289	31	.372	67	480	86.40	1.29	0.77	2.06
Averages									
1981-84									
open water	1765	42	0.280	64	474	108.41	2.29	0.29	2.58
1982-84									
winter	950	23	.244	47	245	47.04	0.90	0.23	1.12
Total	2715	65			719	155.45	3.19	0.52	3.70

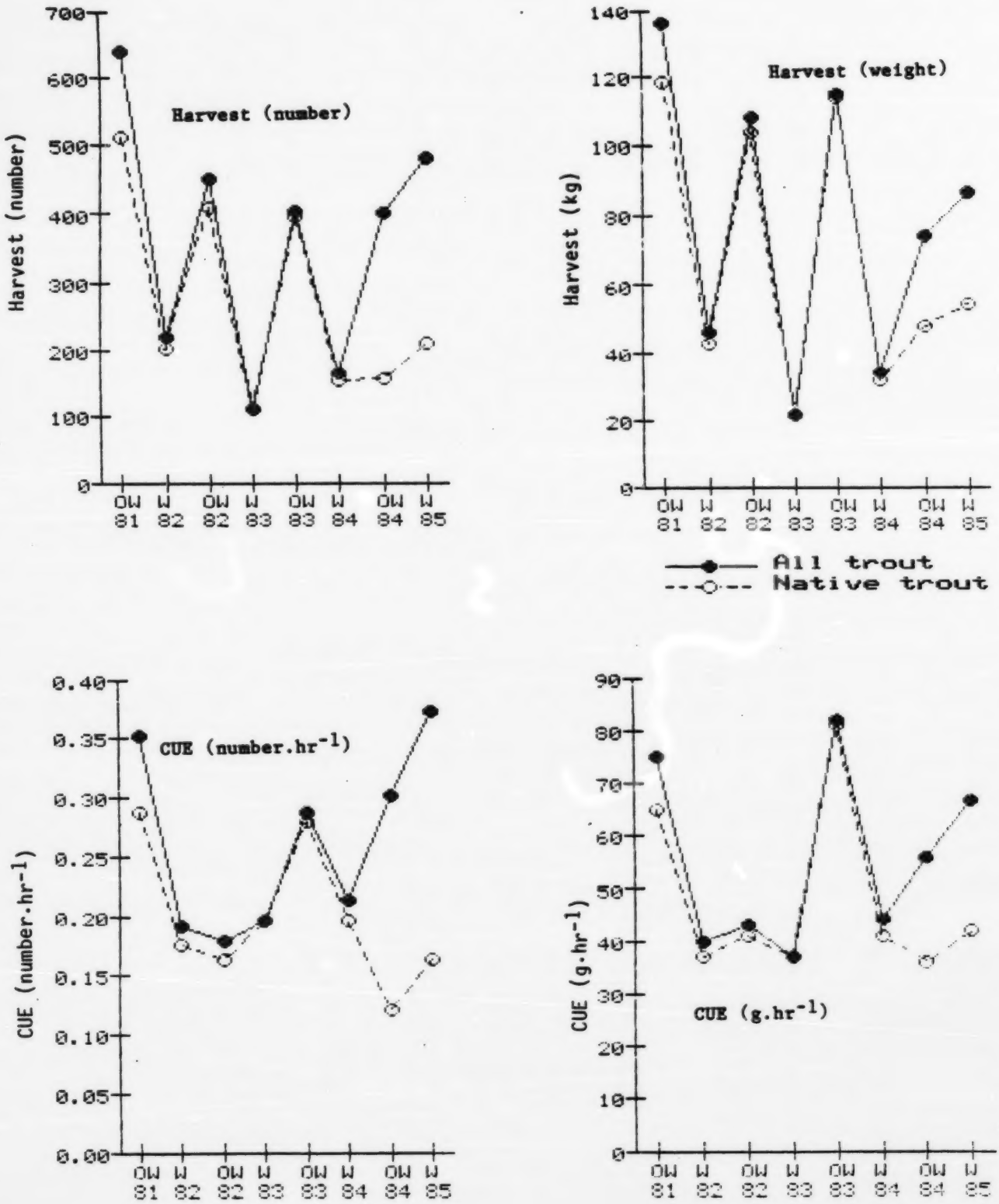

Figure 1. Fishing harvest, and success, Meach Lake, 1981 to 1985.

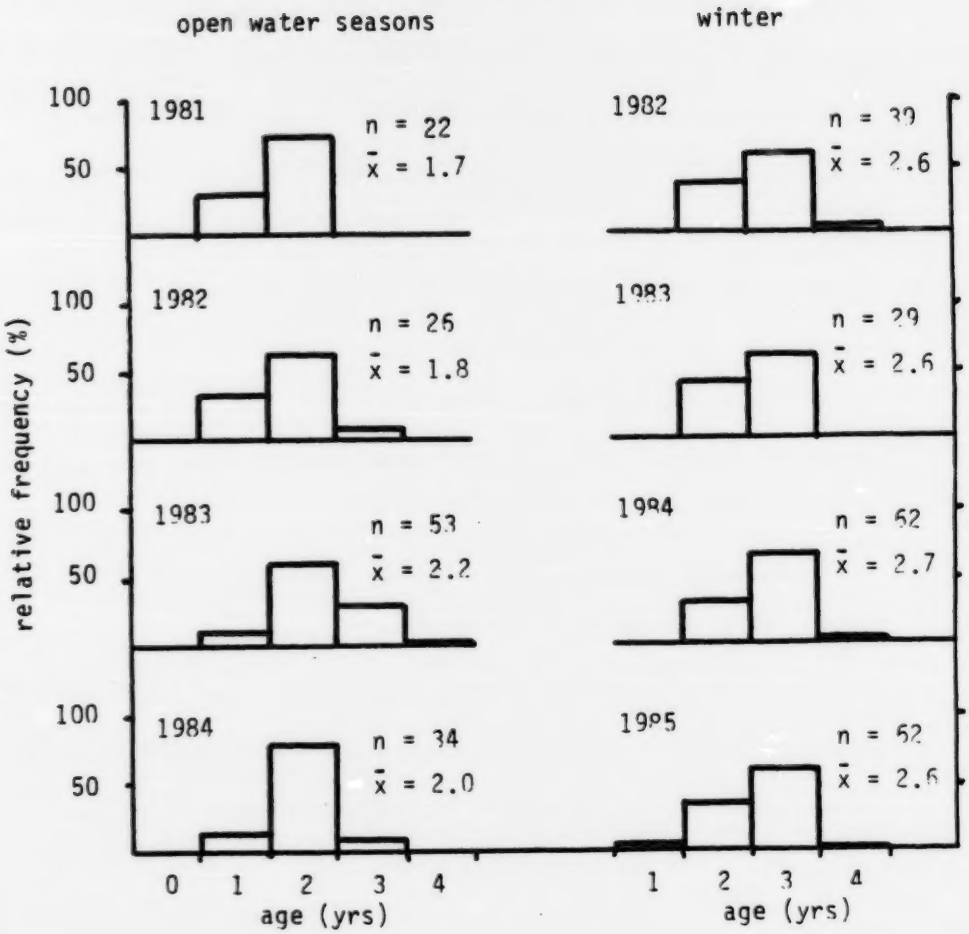

Figure 2. Age composition of seasonal native brook trout catches from Meach Lake, 1981-1985.

Little Meach Lake

Table 2 presents estimates of mean fishing effort, fishing success, and harvest for Little Meach Lake. Average fishing effort was 970 angler hrs (32 hrs.ha^{-1}) during the open water season, 1487 hrs (50 hrs.ha^{-1}) in winter, and 2457 (82 hrs.ha^{-1}) for both seasons combined. Average annual brook trout harvests consisted of about 600 brook trout (including 150 stocked trout) weighing 140.3 kg, which is equivalent to 4.68 kg.ha^{-1}. Yields of native and stocked brook trout were 4.02 kg.ha^{-1}.yr^{-1} and 0.66 kg.ha^{-1}.yr^{-1}, respectively. Average harvests were 261 trout (including about 70 stocked trout) during open water and 339 (including about 80 stocked trout) during the winter period.

Seasonal angling success rates ranged between 0.06 fish.hr^{-1} and 0.56 fish.hr^{-1}. Seasonal average CUE values were 0.29 fish.hr^{-1} (64 g.hr^{-1}) during the open water season and 0.24 fish.hr^{-1} (52 g.hr^{-1}) in winter. Seasonal angling success rates for native and stocked trout are given in Figure 3. Overall average CUE values for native brook trout were 0.24 fish.hr^{-1} (60 g.hr^{-1}) in open water and 0.19 fish.hr^{-1} (41 g.hr^{-1}) in winter.

The age distributions of fish harvested in different seasons is given in Figure 4. More detailed information is provided in Appendix 2. As in Meach Lake, 2 yr old fish, shown as age 3 fish in winter, are the most important age group in catches. In both summer and winter, however, older fish constitute a larger proportion of catches in Little Meach Lake than they do in Meach Lake.

Table 2. Fishing effort and success (angler hours) and fish harvest from Little Meach Lake, 1981-1985.

Season	Effort (angler hrs)		CUE (fish kept)		Harvest		Yield (kg.ha^{-1})		
	hours	hrs.ha^{-1}	no.hr^{-1}	g.hr^{-1}	number	kg	Native	Stocked	Total
1981									
open water	552	18	.560	77	309	42.64	0.92	0.50	1.42
1982									
winter	1869	62	.164	36	306	66.71	1.75	0.47	2.22
open water	1717	57	.267	83	459	143.21	4.28	0.49	4.77
1983									
winter	1024	34	.406	83	416	84.86	2.76	0.07	2.83
open water	868	29	.266	82	231	71.38	2.31	0.07	2.38
1984									
winter	1187	40	.147	39	174	46.81	1.43	0.13	1.56
open water	743	25	.062	14	46	10.16	0.27	0.07	0.34
1985									
winter	1868	62	.245	51	458	95.26	2.32	0.86	3.18
Averages									
1981-84									
open water	970	32	.289	64	261	66.85	1.95	0.28	2.23
1982-85									
winter	1487	50	.241	52	339	73.41	2.07	0.38	2.45
Total	2457	82			600	140.26	4.02	0.66	4.68

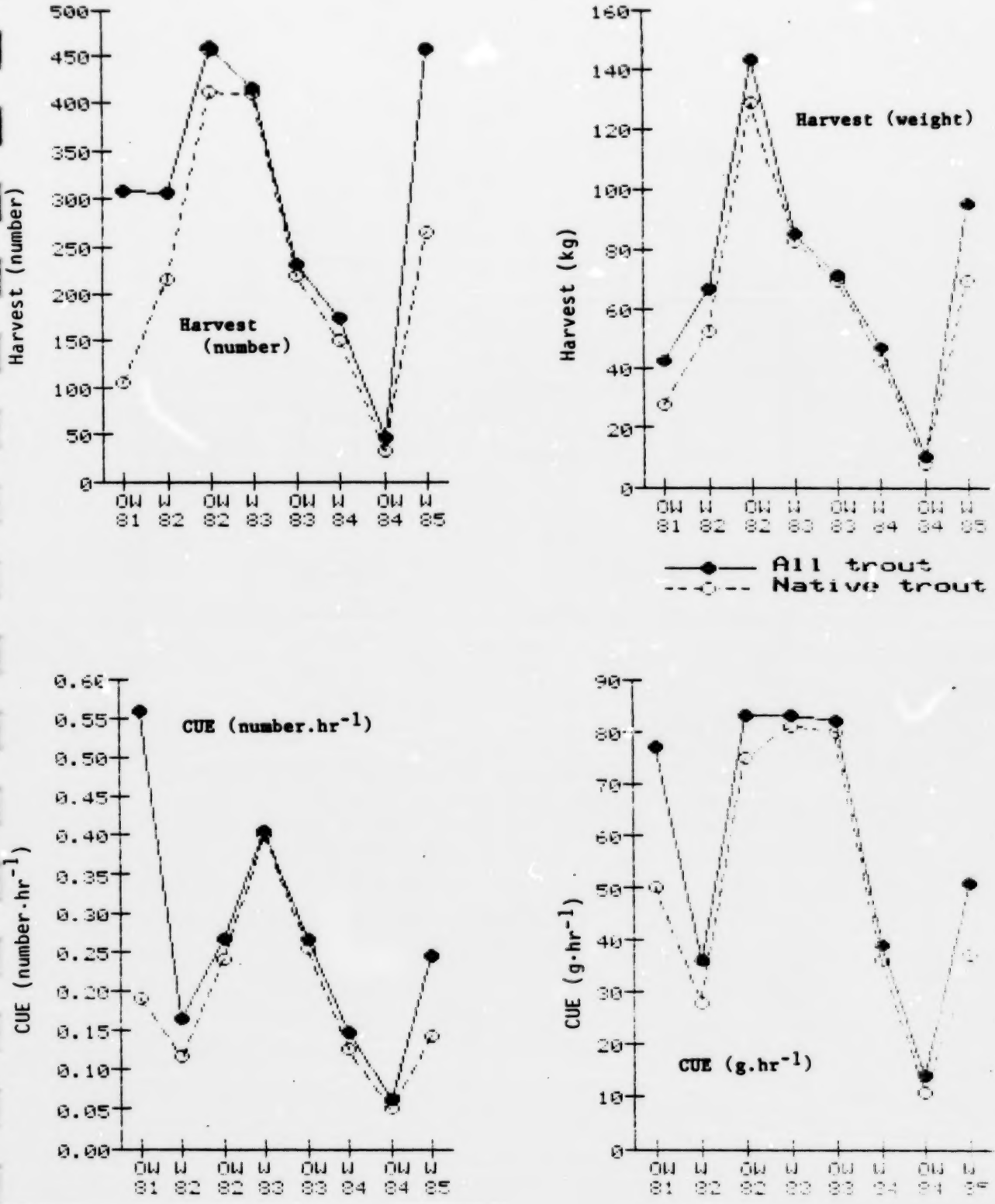

Figure 3. Fishing harvest, and success, Little Meach Lake, 1981-1985.

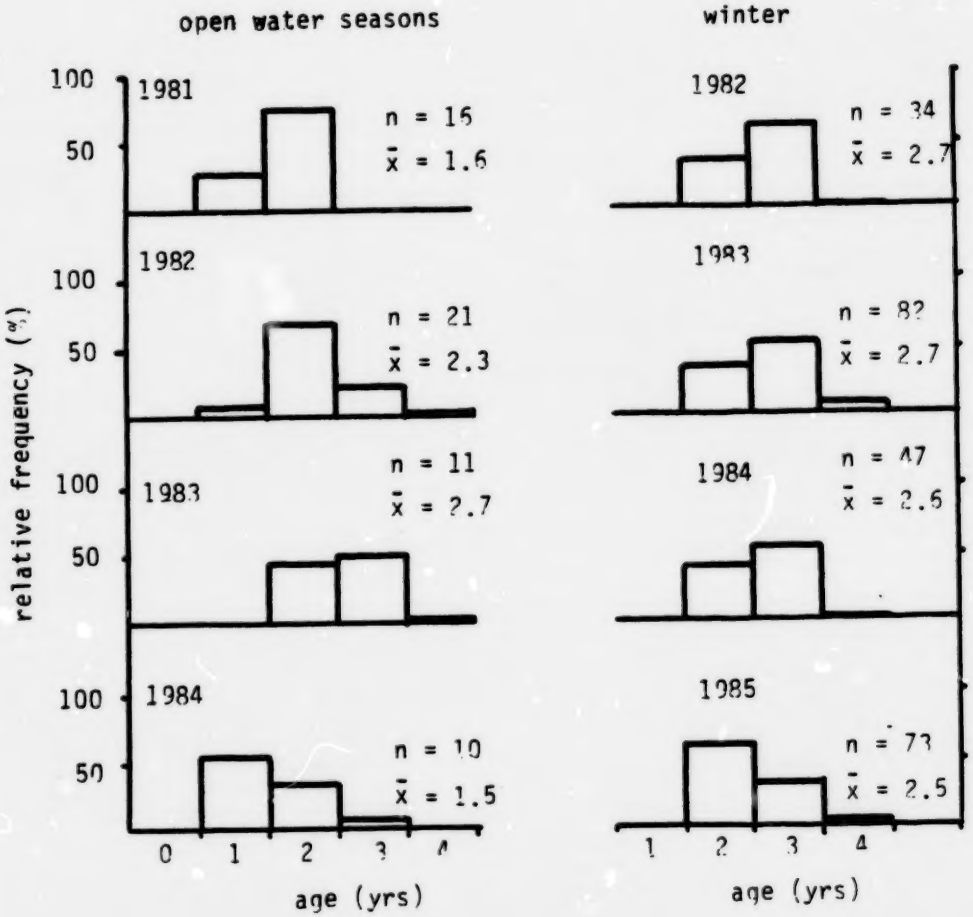

Figure 4. Age composition of seasonal native brook trout catches from Little Meach Lake, 1981-1985.

BROOK TROUT BIOLOGY

We know little about the early life history of brook trout in the Meach Lakes. Spawning activity at one site near the outlet of Little Meach Lake is known to commence in mid-October and to continue until at least mid-November. Young-of-the-year trout can be seen near shore in spring and early summer. A small proportion of them enters the streams where some may reside for up to several years, but the majority remains in the lakes.

Total annual mortality among brook trout fully recruited to the fishery is high. Mortality rate estimates obtained by catch curve analysis were 0.86 for Little Meach Lake and 0.96 for Meach Lake.

Size-at-age data for brook trout from the Meach Lakes are given in Table 3. Growth of native brook trout appears to be quite good for a heavily fished populaton (see Power 1980). Stocked brook trout appeared to be smaller than native trout at age 2.

The stomach contents identified in brook trout were similar in the two lakes (Table 4). During the open water period the predominant food items were fish, crayfish, mayfly nymphs, dipteran larvae, dragonfly nymphs, caddisfly nymphs, and cladocerans. Crayfish, mayfly nymphs, caddisfly nymphs, and fish (including brook trout eggs) were also important during the winter months. Frogs were consumed during winter as well.

Table 3. Fork length (cm) and weight (g) at age of native and stocked winter-caught brook trout from the Meach Lakes, 1981-1985. (Sample sizes, indicated in brackets apply to mean length estimates only.)

Native Age		1982	1983	1984	1985	Mean
1°	L	-	-	-	18.3	18.3
	W	-	-	-	72	72
		(0)	(0)	(0)	(3)	(0.8)
2°	L	25.0	24.3	25.5	25.7	25.2
	W	168	147	174	191	172.4
		(27)	(46)	(40)	(66)	(45)
3°	L	28.4	26.7	29.3	30.4	28.7
	W	250	199	274	334	240
		(44)	(68)	(71)	(57)	(60)
4°	L	33.1	36.6	37.6	39.2	36.6
	W	413	509	560	553	519
		(3)	(8)	(2)	(6)	(4.8)
Stocked						
2°	L	25.1	-	23.8	23.1	23.4
	W	162	-	126	119	124
		(18)	(0)	(15)	(132)	(41.3)
3°	L	27.6	-	-	31.0	29.3
	W	231	-	-	300	266
		(1)	(0)	(0)	(1)	(0.5)
4°	L	-	36.3	-	37.0	36.7
	W	-	509	-	530	520
		(0)	(1)	(0)	(1)	(0.5)

Table 4. Percent frequency of occurence of food item types in brook trout stomachs containing food from Meach Lake and Little Meach Lake, by season, 1981-1985.

	Open Water Period		Winter Period	
	Meach (n = 109)	Little Meach (n = 32)	Meach (n = 186)	Little Meach (n = 245)
Annelida	2.8	0	1.6	0.4
Oligochaeta (oligochaetes)	1.8	0	0	0
Hirudinea (leeches)	0.9	0	1.6	0.4
Crustacea	45.9	46.9	30.6	25.7
Amphipoda (Gammarus, etc.)	0	0	1.1	0.8
Cladocera	20.2	15.6	7.0	9.0
Daphnidae (Daphnia)	5.5	3.1	0.5	1.2
Decapoda	27.5	31.3	24.2	15.9
Astacidae (crayfish)	27.5	31.1	24.2	15.9
Insecta	67.0	62.5	36.6	40.8
Coleoptera (beetles)	7.3	9.4	2.7	4.1
Diptera (flies & midges)	17.4	9.4	0	2.4
Chaoboridae (phantom midges)	2.8	0	0	0.8
Chironomidae (chironomids)	6.4	3.1	0	0.4
Ephemeroptera (mayflies)	23.9	15.6	14.5	22.4
Hemiptera	0.9	0	3.8	1.6
Corixidae (water boatmen)	0.9	0	3.8	1.6
Hymenoptera (ants)	0	6.3	0	0
Megaloptera	0	3.1	0.5	0.4
Corydalidae (dobsonflies)	0	3.1	0	0
Sialidae (alderflies)	0	0	0.5	0.4
Odonata (dragonflies)	5.5	9.4	0	2.0
Trichoptera (caddisflies)	2.8	6.3	8.1	8.6
Mollusca	0	0	0	0.4
Gastropoda (snails)	0	0	0	0.4
Pisces	23.6	15.6	36.6	39.6
Cyprinidae	12.8	6.3	9.7	12.2
Chrosomus eos (redbelly dace)	0	0	1.6	1.2
Pimephales promelas (fathead minnow)	2.8	0	4.8	6.9
Semotilus atromaculatus (creek chub)	0	0	0	0.8
Gasterosteidae	0	3.1	1.1	1.2
Culaea inconstans (brook stickleback)	0	3.1	1.1	1.2
Salmonidae	0	0	0.5	3.7
Salvelinus fontinalis (eggs)	0	0	0.5	3.7
Salientia (frogs & toads)	0	0	4.8	4.5
Urodela (salamanders)	0	0	0	0.4
Other	9.2	15.7	24.2	24.5
Baitfish	0.9	0	12.4	10.6
Other bait (worms, corn, liver)	4.6	9.4	1.1	3.3
Debris (gravel, sticks)	2.8	0	9.1	10.6
Miscellaneous (cigarette butts, fish hooks, spruce needles, plant seeds)	0.9	6.3	1.6	0

DISCUSSION

YIELD

Brook trout yields from the Meach Lakes were typical of those observed by Fraser (1980, 1981) in Algonquin Park lakes containing fish of hatchery origin. They were, however, much higher than those recommended by SPOF Working Group Number Twelve (OMNR 1982). SPOF Group 12 suggested that, in the absence of suitable yield data from Ontario brook trout lakes, the guideline for brook trout yields should be similar to that for lake trout. It stipulated the yields should not exceed 0.75 $kg.ha^{-1}.yr^{-1}$ or 25% of the potential yeild ($\hat{Y}$, $kg.ha^{-1}.yr^{-1}$) estimated using Ryder's (1965) MEI model,

$$\hat{Y} = 1.4\ (MEI)^{0.45}$$

However, published data (eg MacCrimmon and Berst 1961) suggest that sustainable yields of brook trout may be far in excess of this in some cases.

To establish whether a more realistic yield guideline could be developed for brook trout waters, we used data from 10 lakes, including the Meach Lakes, supporting moderate to intensive fisheries for native brook trout. Data for the Glen Major Ponds and Moosehead Lake were provided by MacCrimmon and Berst (1961) and AuClair (1978), respectively. Data for Dickson Lake, Lake Lavieille, Little Crooked Lake and Redrock Lake were provided by the Algonquin Fisheries Assessment Unit

and Fisheries Research Section, OMNR. We assumed that brook trout yields from these lakes could be used as estimates of brook trout potential yields (Y_{BT}) because of the relatively high intensity of each of the fisheries. Table 5 summarizes brook trout potential yield estimates for 10 lakes as well as data on lake surface area, mean depth, and total dissolved solids (TDS) concentrations. Simple linear regression and correlation techniques were applied to see if brook trout potential yield estimates could be related to morphoedaphic index values or to lake surface area.

A regression of $\log_{10}$ brook trout yield ($\log_{10}Y_{BT}$) against $\log_{10}$ MEI gave the equation

$$\log_{10} \hat{Y}_{BT} = 1.14 \, (\log_{10}\text{MEI}) - 0.77 \qquad (1a)$$

where n=10, df=8, and $r^2 = 0.88$. This relationship, shown graphically in Figure 5, can also be expressed as

$$\hat{Y}_{BT} = \frac{\text{MEI}^{1.14}}{5.89} \qquad (1b)$$

The distribution of individual data points in Fig 5a is such that the Meach Lakes exhibit the largest residuals, and the only strong positive residuals. This could be taken as an indication that the Meach Lakes are overfished. In fact, exclusion of the Meach Lakes data from the calculation resulted in the equation

Table 5. Potential yield estimates (Y_{BT}) and limnological data from 10 lakes supporting moderate to intensive fisheries.

Lake	Area (ha)	TDS ($mg.l^{-1}$)	Z (m)	MEI	$\hat{Y}$ ($kg.ha^{-1}.yr^{-1}$)	Total Yield ($kg.ha^{-1}.yr^{-1}$)	Y_{BT} ($kg.ha^{-1}.yr^{-1}$)	Source
Dickson	975	33.3	5.5	6.05	3.15	-	0.49	F. Hicks (pers comm)
Glen Major A	0.77	200.0	0.9	220.0	14.3	79.2	79.2	MacCrimmon & Berst (1961)
Glen Major B	0.65	200.0	1.4	146.0	11.7	57.7	57.7	MacCrimmon & Berst (1961)
Glen Major C	0.65	200.0	1.3	154.0	12.0	40.0	40.0	MacCrimmon & Berst (1961
Lavieille	2404	31.6	14.4	2.19	1.75	0.60	0.23	F. Hicks (pers comm)
Little Crooked	92	35.0	4.0	8.75	3.72	1.16	1.16	F. Hicks (pers comm)
Little Meach	30	26.5	9.4	2.81	2.23	4.02	4.02	--
Meach	42	26.5	4.8	5.52	3.02	3.19	3.19	--
Moosehead	34,040	-	-	0.48	0.48	0.45	0.04	AuClair (1978)
Redrock	291	21.0	14.4	2.42	2.42	-	0.41	F. Hicks (pers comm)

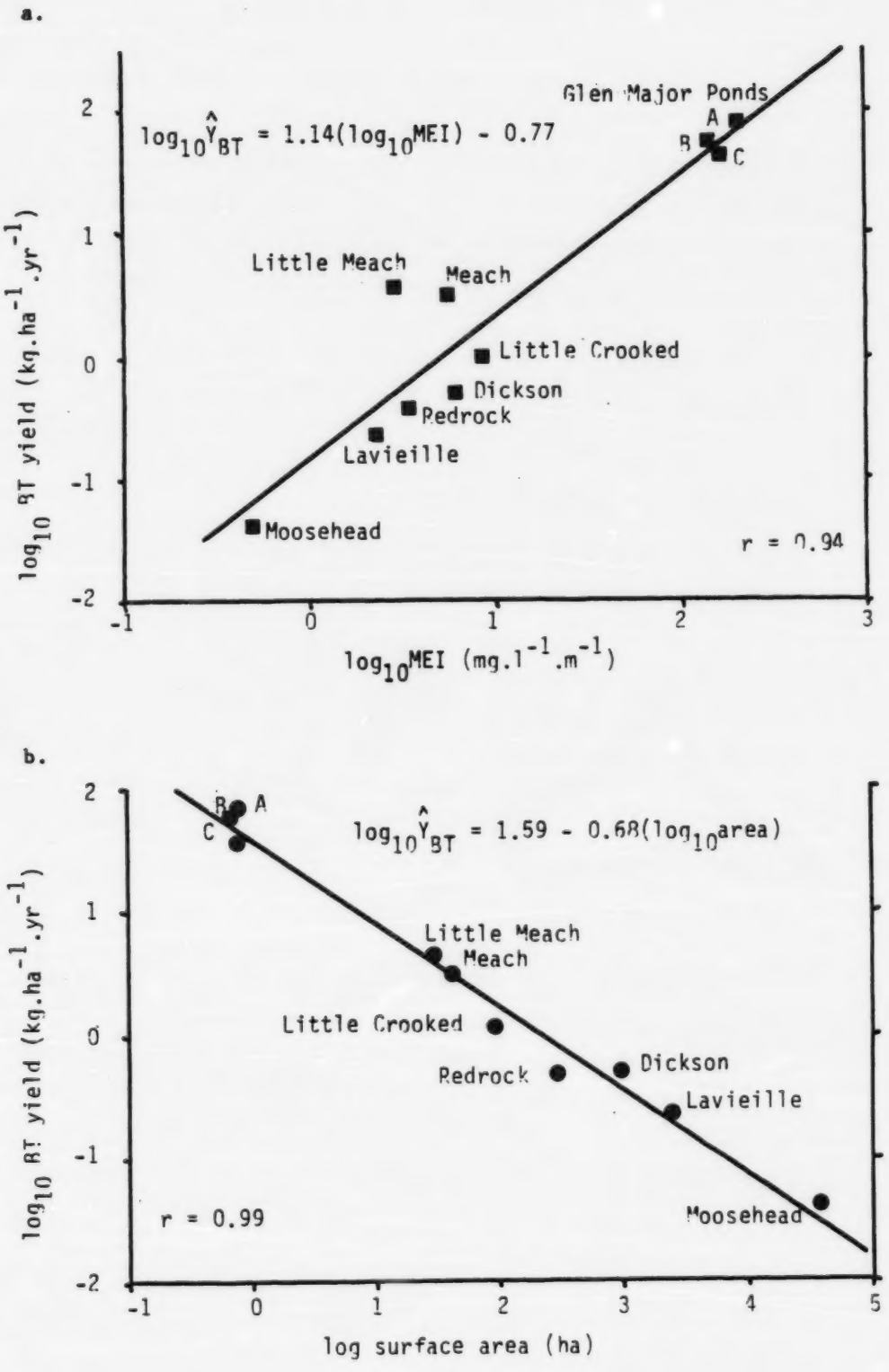

Figure 5. Brook trout potential yield estimates in relation to the morphoedaphic index and lake surface area.

$$\log_{10}\hat{Y}_{BT} = 1.24\ (\log_{10}MEI) - 1.05 \qquad (2a)$$

or

$$\hat{Y}_{BT} = \frac{MEI^{1.24}}{11.22} \qquad (2b)$$

where n=8, df=6, and r^2=0.99. However, exclusion of the extreme data points associated with the three Glen Major Ponds and Moosehead Lake resulted in a correlation coefficient of only 0.31 (r^2 = 0.10), an indication that this relationship is not very robust.

The regression equation calculated to describe the relation between brook trout yield and lake surface area was

$$\log_{10}\hat{Y}_{BT} = 1.59 - 0.68\ (\log_{10}A) \qquad (3a)$$

where A=surface area (ha), n=10, df=8, and r^2=0.98. Expressed otherwise, this relationship is

$$\hat{Y}_{BT} = \frac{38.90}{A^{0.68}} \qquad (3b)$$

In this instance, the residuals associated with the Meach Lakes were negligible (Fig 5b). Also, the correlation between brook trout yield and lake surface area remained quite strong (r = 0.95; r^2 = 0.90) even when data for the Glen Major Ponds and Moosehead Lake were left out of the calculation.

The strength of these relationships affirms that a more realistic guideline for brook trout yields can be developed on the basis of data now available. The relation between potential brook trout yield and lake surface area, which we judge to be the more robust of the two, also suggests that yields from the Meach Lakes are not excessive.

ASSESSMENT OF EXPLOITATION STRESS

SPOF WG 15 (OMNR 1983) recommended the use of several other criteria, in addition to yield, to assess the exploitation stress experienced by fish populations. These criteria were: abundance (historical trends, across lake comparisons, trend analysis, variability in abundance); age structure; total mortality; mean age; relative year class strength; year class strength variability; growth; and age at maturity. Unfortunately there are no historical data from the Meach Lakes and our own observations have been made over too short a time period (4 yr) to permit analysis either of trends in the fishery or of variablity in year class strength and abundance. Abundance can be addressed in a general way, however, and criteria relating to total mortality, mean age, growth, and age-at-maturity can be considered as well.

Our general feeling that the Meach Lakes brook trout are relatively abundant and that the population has remained stable in recent years is based on the success anglers have enjoyed, and on reports from locals that fishing effort and success were much the same during the 1970's as they are at present. Total annual mortality rates (0.96 in Meach Lake, 0.86 in Little Meach Lake) are quite high, however, and reflect the high intensity of the fishery. They may be excessive, but the present data series is too short to support a conclusion in this respect. Harvest and CUE estimates for native brook trout declined sharply from 1983 to 1984, especially in Little Meach Lake (Table 6), and this appears to have been the result of a relatively weak 1982 year class (see Appendix tables). Improved catches in the winter of 1985 resulted from strong recruitment of the 1983 year class.

The mean age of brook trout harvested from the Meach Lakes has been about 2.6 years in winter and about 2.0 years during the open water season, with an overall weighted mean of 2.4 years, or about 29 months.

Table 6. Angling effort and success at catching native brook trout during the period 1982 to 1984.

	Effort (angler hrs)	Harvest (no. kept)	CUE (no.hr^{-1})	Harvest (kg kept)	CUE (kg.hr^{-1})
Meach					
1982	3660*	612***	0.17	140***	0.04
1983	1989	511	0.26	137	0.07
1984	2109	314	0.15	79	0.04
Little Meach					
1982	2586**	630****	0.24	174****	0.07
1983	1892	633	0.33	152	0.08
1984	1930	183	0.09	52	0.03

* Meach Lake effort data from Table 1.

** Little Meach Lake effort data from Table 2.

*** Meach Lake harvest data from Figure 1

**** Little Meach Lake harvest data from Figure 3.

About 60% of the brook trout spawn for the first time during their second year, 80% spawn during their third year, and all are mature in their fourth year. According to Lysack's formula (OMNR 1983), the weighted mean age at first maturity is 27.2 months. Abrosov's "t" (mean age of catch-mean age at first maturity) is therefore positive, but only by a small margin. These are further indications of the high intensity of the fishery.

RETURNS OF HATCHERY-REARED BROOK TROUT

Returns of brook trout planted in the Meach Lakes show that fish stocked in either of the lakes subsequently dispersed throughout both lakes. Therefore, in this analysis, we treated the lakes as a single entity.

A summary of pertinent data on individual recent plantings in the Meach Lakes is given in Table 7.

Table 7. Plantings of hatchery-reared brook trout in the Meach Lakes, 1980-1984.

Year	Month	Lake	No. Planted	Strain*	Rate (#.ha^{-1})	Mean wt (g.)	Rate (kg.ha^{-1})	Clip
1980	April	Meach	4700	D	112	8	0.9	NC
1981	June	L.Meach	3000	D	100	35	3.5	RP
1982	May	Meach	3700	N	88	11	1.0	RV
1983	May	L.Meach	3600	N	120	24	2.9	AD
1984	May	Meach	7800	N	186	30	5.6	LV

* domestic (D) or Nipigon (N).

Fish planted in 1980 were unclipped so that returns to the fishery could not be assessed. Summary return data for subsequent plantings made in 1981, 1982, and 1983 are provided in Table 8 below.

Table 8. Returns over 2 years to anglers from brook trout plantings made in 1981, 1982, and 1983.

Year	1981	1982	1983
Strain	Domestic	Nipigon	Nipigon
Number planted	3000	3700	3600
Rate ($no.ha^{-1}$)	41.7	51.4	50.0
Return ($no.ha^{-1}$)	5.8	0.6	1.3
Return (%, no)	14.0	1.2	2.5
Mean weight (g)	35	11	24
Gross weight (kg)	105	41	86
Rate ($kg.ha^{-1}$)	1.46	0.57	1.20
Return ($kg.ha^{-1}$)	0.64	0.08	0.22
Return (%, wt)	44.0	13.6	18.0

Recovery rates for the 3 plantings for which complete data are available ranged from 1.2% to 14% by number and from 13.6% to 44%, by weight. Returns appear to vary directly with size at planting (Fig 6).

It appears that the practise of planting hatchery-reared brook trout in the Meach Lakes is not warranted either by a need for supplemental production or by good returns of planted fish. Our tentative view is that plantings may, in fact, be detrimental in cases such as this where good populations of native brook trout are present. The presence of large numbers of hatchery fish may result in increased competition among young brook trout. Successful spawning by hatchery fish may also lead to dilution of the native gene pool. Most important, though, is the possibility that the known presence of hatchery fish attracts anglers to lakes thereby increasing pressure on native brook trout.

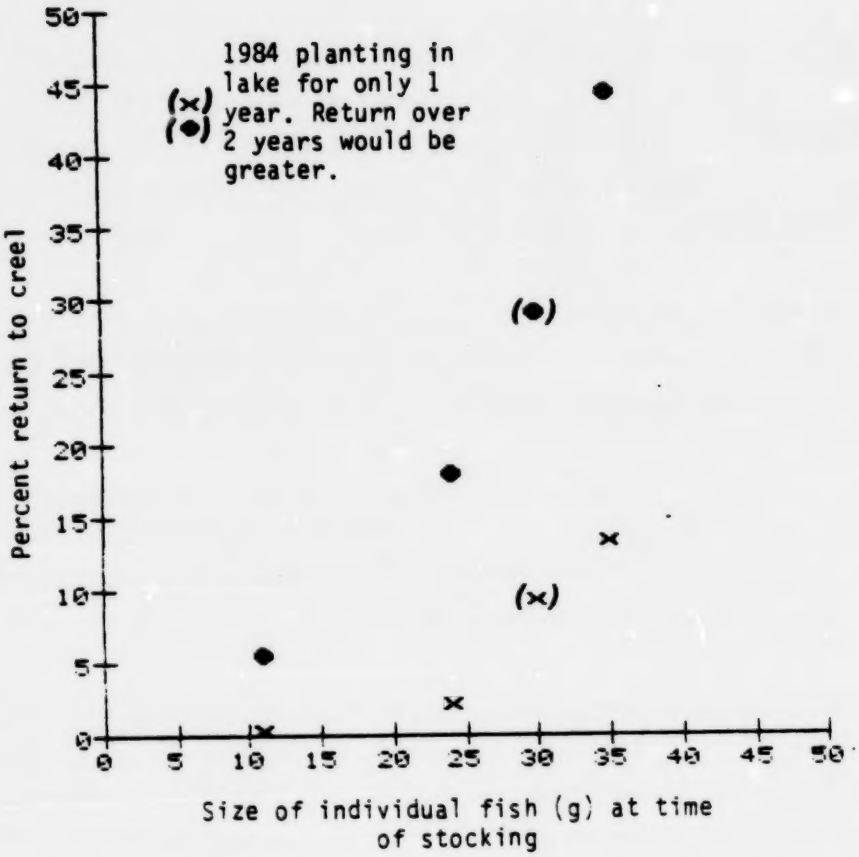

Figure 6. Return of hatchery planted brook trout to the creel by number (x) and by weight (●) over two years following planting, relative to size-at-planting. Meach and Little Meach Lakes, 1981-1985.

CONCLUSIONS AND RECOMMENDATIONS

The brook trout fishery of the Meach Lakes is intense and the brook trout population exhibits some signs - early maturity, high mortality rate, high yield - of heavy exploitation stress. However, it shows no signs of distress.

Brook trout yields from the Meach Lakes greatly exceeded the guideline yield specified by SPOF Working Group 12 (OMNR 1982). Our view is that this reflects the need for revision of the guideline. Yields do not seem excessive when viewed in relation to those from other productive brook trout fisheries.

Although plantings of hatchery-reared yearling brook trout have led to substantial increases in angler harvest and success in some seasons, returns have tended to be quite poor. In this instance, given the existence of a productive endemic brook trout stock, the use of hatchery stock is unjustified. It may also be detrimental to the native fish. The relative success of different plantings appears to be related to size-at-planting more than to the strain used as brood stock.

Persistence of the Meach Lakes brook trout fishery is attributable to the excellent trout habitat present, as well as to the relative isolation of the lakes. Maintenance of the fishery will depend primarily on preventing a further increase in fishing effort and preventing the introduction of exotic species, especially yellow perch (*Perca flavescens*), smallmouth bass (*Micropterus dolomieui*), rock bass (*Ambloplites rupestris*) and northern pike (*Esox lucius*).

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APPENDIX 1

Summary statistics for native and

stocked Meach Lake brook trout, by season.

Appendix 1. Summary statistics for Meach Lake brook trout by age class, open water, 1981.

Year class	1980	1979	1978	1977	Total
Age	1+	2+	3+	4+	
Natives					
# caught	152	372	0	0	524
# sampled	6	14	0	0	20
% of total catch	23.8	58.2	0	0	82
Mean lenth (cm)	22.4	27.6	-	-	26.0
Mean weight (grams)	138	247	-	-	215
CUE (#.hr)	.062	.201	0	0	.283
CUE (grams.hr)	11	50	0	0	61
Stocked					
# caught	77	37	0	0	115
# sampled	3	2	0	0	5
% of total catch	12.1	5.8	0	0	18
Mean length (cm)	18.5	27.6	-	-	21.3
Mean weight (grams)	120	247	-	-	160
CUE (#.hr)	.042	.020	0	0	.062
CUE (grams.hr)	5	5	0	0	10

Appendix 1. Summary statistics for Meach Lake brook trout by age class, winter, 1982.

Year	1981	1980	1979	1978	Total
Age	1	2	3	4	
Natives					
# caught	0	75	117	10	202
# sampled	0	14	21	2	37
% of total catch	0	34.1	53.2	4.5	92
Mean length (cm)	-	25.7	27.6	29.2	27.0
Mean weight (grams)	-	185	231	280	216
CUE (#.hr)	0	.058	.090	.008	.156
CUE (grams.hr)	0	11	21	2	34
Stocked					
# caught	N/A	16	2	0	18
# sampled	N/A	3	1	0	4
% of total catch	N/A	7.3	0.9	0	8
Mean length (cm)	N/A	25.6	27.6	-	25.8
Mean weight (grams)	N/A	163	231	-	171
CUE (#.hr)	N/A	.012	.002	0	.014
CUE (grams.hr)	N/A	2	<1	0	2

Appendix 1. Summary statistics for Meach Lake brook trout by age class, open water, 1982.

Year	1981	1980	1979	1978	Total
Age	1+	2+	3+	4+	
Natives					
# caught	130	250	30	0	410
# sampled	13	25	3	0	41
% of total catch	28.9	55.6	6.7	0	91
Mean length (cm)	22.6	27.9	31.0	-	26.4
Mean weight (grams)	136	265	433	-	236
CUE (#.hr)	.050	.096	.011	0	.157
CUE (grams.hr)	7	25	5	0	37
Stocked					
# caught	30	10	0	0	40
# sampled	3	1	0	0	4
% of total catch	6.7	2.2	0	0	9
Mean lenght (cm)	20.7	22.5	-	-	21.2
Mean weight (grams)	85	160	-	-	104
CUE (#.hr)	.012	.004	0	0	.016
CUE (grams.hr)	1	1	0	0	2

Appendix 1. Summary statistics for Meach Lake brook trout by age class, winter, 1983.

Year	1982	1981	1980	1979	Total
Age	1	2	3	4	
Natives					
# caught	0	47	66	0	113
# sampled	0	12	17	0	29
% of total catch	0	41.4	58.6	0	100
Mean length (cm)	-	24.9	26.8	-	26.0
Mean weight (grams)	-	163	210	-	190
CUE (#.hr)	0	.082	.117	0	.199
CUE (grams.hr)	0	13	25	0	38
Stocked					
# caught	N/A	0	0	0	0
# sampled	N/A	0	0	0	0
% of total catch	N/A	0	0	0	0
Mean length (cm)	N/A	0	0	0	0
Mean weight (grams)	N/A	0	0	0	0
CUE (#.hr)	N/A	0	0	0	0
CUE (grams.hr)	N/A	0	0	0	0

Appendix 1. Summary statistics for Meach Lake brook trout by age class, open water, 1983.

Year	1982	1981	1980	1979	Total
Age	1+	2+	3+	4+	
Natives					
# caught	39	235	118	7	398
# sampled	6	36	18	1	61
% of total catch	9.7	58.1	29.0	1.6	98
Mean length (cm)	22.1	28.3	30.6	31.0	28.5
Mean weight (grams)	154	282	348	-	290
CUE (#.hr)	.022	.135	.067	.004	.227
CUE (grams.hr)	3	38	23	1	66
Stocked					
# caught	7	0	0	0	7
# sampled	1	0	0	0	1
% of total catch	1.6	0	0	0	2
Mean length (cm)	19.0	-	-	-	19.0
Mean weight (grams)	100	-	-	-	100
CUE (#.hr)	.004	0	0	0	.004
CUE (grams.hr)	<1	0	0	0	<1

Appendix 1. Summary statistics for Meach Lake brook trout by age class, winter, 1984.

Year	1983	1982	1981	1980	Total
Age	1	2	3	4	
Natives					
# caught	0	48	100	5	153
# sampled	0	21	44	2	67
% of total catch	0	28.4	59.5	2.7	91
Mean length (cm)	-	25.1	27.6	-	25.9
Mean weight (grams)	-	167	227	560	219
CUE (#.hr)	0	.069	.144	.007	.221
CUE (grams.hr)	0	12	33	4	48
Stocked					
# caught	N/A	15	0	0	15
# sampled	N/A	7	0	0	7
% of total catch	N/A	94	0	0	9
Mean length (cm)	N/A	22.9	-	-	22.9
Mean weight (grams)	N/A	111	-	-	111
CUE (#.hr)	N/A	.022	0	0	.022
CUE (grams.hr)	N/A	2	0	0	2

Appendix 1. Summary statistics for Meach Lake brook trout by age class, open water, 1984

Year	1983	1982	1981	1980	Total
Age	1+	2+	3+	4+	
Natives					
# caught	21	126	14	0	161
# sampled	6	36	4	0	46
% of total catch	5.3	31.6	3.5	0	40
Mean length (cm)	21.5	29.4	35.6	-	28.9
Mean weight (grams)	108	291	488	-	284
CUE (#.hr)	.018	.108	.012	0	.137
CUE (grams.hr)	2	31	6	0	39
Stocked					
# caught	198	42	0	0	240
# sampled	56	12	0	0	68
% of total catch	49.1	10.5	0	0	60
Mean length (cm)	18.9	29.2	-	-	20.7
Mean weight (grams)	75	281	-	-	111
CUE (#.hr)	.168	.036	0	0	.206
CUE (grams.hr)	13	10	0	0	23

Appendix 1. Summary statistics for Meach Lake brook trout by age class, winter, 1985.

Year	1984	1983	1982	1981	Total
Age	1	2	3	4	
Natives					
# caught	10	71	121	7	208
# sampled	3	21	36	2	62
% of total catch	2.1	14.7	25.2	1.4	43
Mean length (cm)	18.0	25.2	31.1	30.5	28.6
Mean weight (grams)	72	176	330	385	268
CUE (#.hr)	.006	.044	.075	.004	.129
CUE (grams.hr)	<1	8	25	2	35
Stocked					
# caught	N/A	269	3	0	272
# sampled	N/A	80	1	0	81
% of total catch	N/A	55.9	0.7	0	57
Mean length (cm)	N/A	22.9	31.0	-	23.0
Mean weight (grams)	N/A	112	300	-	114
CUE (#.hr)	N/A	.166	.002	0	.168
CUE (grams.hr)	N/A	19	1	0	19

APPENDIX 2

Summary statistics for native and stocked Little Meach Lake brook trout, by season.

Appendix 2. Summary statistics for Little Meach Lake brook trout by age class, open water, 1981

Year	1980	1979	1978	1977	Total
Age	1+	2+	3+	4+	
Natives					
# caught	25	67	0	0	92
# sampled	2	5	0	0	7
% of total catch	80	21.6	0	0	30
Mean length (cm)	24.8	31.5	-	-	29.7
Mean weight (grams)	235	339	-	-	311
CUE (#.hr)	.044	.119	0	0	.164
CUE (grams.hr)	10	40	0	0	51
Stocked					
# caught	209	7	0	0	216
# sampled	17	1	0	0	18
% of total catch	68.0	2.3	0	0	70
Mean length (cm)	20.1	31.5	-	-	19.7
Mean weight (grams)	79	339	-	-	85
CUE (#.hr)	.375	.013	0	0	.386
CUE (grams.hr)	30	4	0	0	33

Appendix 2. Summary statistics for Little Meach Lake brook trout by age class, winter, 1982.

Year	1981	1980	1979	1978	Total
Age	1	2	3	4	
Natives					
# caught	0	77	135	6	218
# sampled	0	13	23	1	37
% of total catch	0	25.0	44.2	1.9	71
Mean length (cm)	-	24.0	29.1	41.0	27.6
Mean weight (grams)	-	150	267	680	237
CUE (#.hr)	0	.038	.068	.003	.109
CUE (grams.hr)	0	6	18	3	26
Stocked					
# caught	N/A	88	0	0	88
# sampled	N/A	15	0	0	15
% of total catch	N/A	28.8	0	0	29
Mean lenght (cm)	N/A	25.0	-	-	25.0
Mean weight (grams)	N/A	162	-	-	162
CUE (#.hr)	N/A	.044	0	0	.044
CUE (grams.hr)	N/A	7	0	0	7

Appendix 2. Summary statistics for Little Meach Lake brook trout age class, open water, 1982.

Year	1981	1980	1979	1978	Total
Age	1+	2+	3+	4+	
Natives					
# caught	32	269	95	16	412
# sampled	2	17	6	1	26
% of total catch	6.9	58.6	20.7	3.4	90
Mean length (cm)	21.5	27.6	31.6	45.0	28.7
Mean weight (grams)	200	239	390	900	296
CUE (#.hr)	.014	.120	.042	.007	.183
CUE (grams.hr)	3	29	16	6	54
Stocked					
# caught	0	16	32	0	47
# sampled	0	1	2	0	3
% of total catch	0	3.4	6.9	0	10
Mean length (cm)	-	19.0	31.6	-	28.0
Mean weight (grams)	-	180	390	-	327
CUE (#.hr)	0	.007	.014	0	.021
CUE (grams.hr)	0	1	5	0	7

Appendix 2. Summary statistics for Little Meach Lake brook trout by age class, winter, 1983.

Year	1982	1981	1980	1979	Total
Age	1	2	3	4	
Natives					
# caught	0	150	226	35	412
# sampled	0	34	51	8	93
% of total catch	0	36.2	54.3	8.5	99
Mean length (cm)	-	24.1	26.7	36.3	26.5
Mean weight (grams)	-	142	195	509	202
CUE (#.hr)	0	.124	.189	.030	.345
CUE (grams.hr)	0	18	37	15	70
Stocked					
# caught	N/A	0	0	4	4
# sampled	N/A	0	0	1	1
% of total catch	N/A	0	0	1	1
Mean length (cm)	N/A	-	-	36.3	36.3
Mean weight (grams)	N/A	-	-	509	509
CUE (#.hr)	N/A	0	0	.004	.004
CUE (grams.hr)	N/A	0	0	2	2

Appendix 2. Summary statistics for Little Meach Lake brook trout by age class, open water, 1983.

Year	1982	1981	1980	1979	Total
Age	1+	2+	3+	4+	
Natives					
# caught	0	100	110	10	221
# sampled	0	10	11	1	22
% of total catch	0	43.5	47.8	4.3	96
Mean length (cm)	-	27.5	31.6	33.5	29.8
Mean weight (grams)	-	267	338	460	311
CUE (#.hr)	0	.078	.086	.008	.172
CUE (grams.hr)	0	21	29	4	53
Stocked					
# caught	10	0	0	0	10
# sampled	1	0	0	0	1
% of total catch	4.3	0	0	0	4
Mean lenght (cm)	23.0	-	-	-	23.0
Mean weight (grams)	-	-	-	-	-
CUE (#.hr)	.008	0	0	0	.008
CUE (grams.hr)	2	0	0	0	2

Appendix 2. Summary statistics for Little Meach Lake brook trout by age class, winter, 1984.

Year	1983	1982	1981	1980	Total
Age	1	2	3	4	
Natives					
# caught	0	59	84	6	149
# sampled	0	19	27	2	48
% of total catch	0	33.9	48.2	3.6	86
Mean length (cm)	-	26.0	31.9	37.6	29.8
Mean weight (grams)	-	181	350	560	292
CUE (#.hr)	0	.043	.062	.005	.110
CUE (grams.hr)	0	8	22	3	32
Stocked					
# caught	N/A	25	0	0	25
# sampled	N/A	8	0	0	8
% of total catch	N/A	14.3	0	0	14
Mean length (cm)	N/A	24.5	-	-	24.5
Mean weight (grams)	N/A	140	-	-	140
CUE (#.hr)	N/A	.018	0	0	.018
CUE (grams.hr)	N/A	3	0	0	3

Appendix 2. Summary statistics for Little Meach Lake brook trout by age class, open water, 1984.

Year	1983	1982	1981	1980	Total
Age	1+	2+	3+	4+	
Natives					
# caught	19	12	3	0	34
# sampled	6	4	1	0	11
% of total catch	40.0	26.7	6.7	0	73
Mean length (cm)	22.9	31.6	34.0	-	27.0
Mean weight (grams)	132	372	450	-	245
CUE (#.hr)	.050	.033	.008	0	.091
CUE (grams.hr)	7	12	4	0	22
Stocked					
# caught	6	3	3	0	12
# sampled	2	1	1	0	4
% of total catch	13.3	6.7	6.7	0	27
Mean length (cm)	21.9	30.5	27.0	-	25.3
Mean weight (grams)	90	300	220	-	175
CUE (#.hr)	.017	.008	.008	0	.034
CUE (grams.hr)	2	2	2	0	6

Appendix 2. Summary statistics for Little Meach Lake brook trout by age class, winter, 1985.

Year	1984	1983	1982	1981	Total
Age	1	2	3	4	
Natives					
# caught	0	164	84	18	265
# sampled	0	45	23	5	73
% of total catch	0	35.8	18.3	3.9	58
Mean length (cm)	-	25.9	29.7	38.8	28.1
Mean weight (grams)	-	198	311	620	263
CUE (#.hr)	0	.099	.048	.010	.152
CUE (grams.hr)	0	20	15	6	40
Stocked					
# caught	N/A	189	0	4	193
# sampled	N/A	52	0	1	53
% of total catch	N/A	41.3	0	0.9	42
Mean length (cm)	N/A	23.3	-	37.0	23.6
Mean weight (grams)	N/A	129	-	530	137
CUE (#.hr)	N/A	.109	0	.002	.110
CUE (grams.hr)	N/A	14	0	1	15